

Q



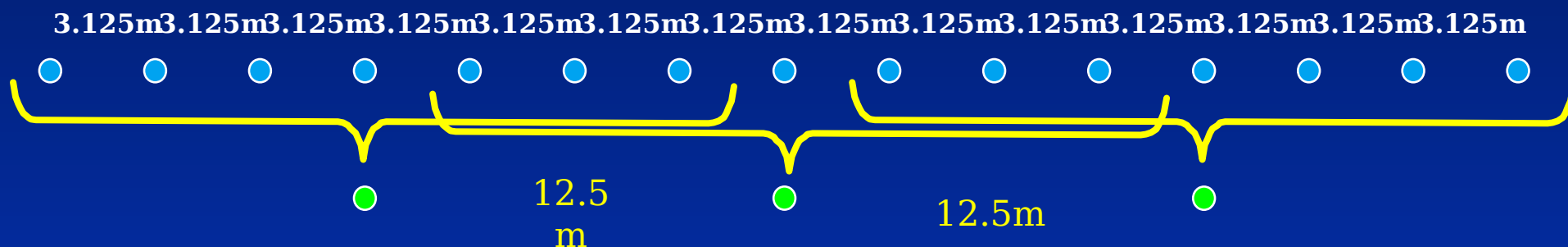
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How Far have we Come?

Overview

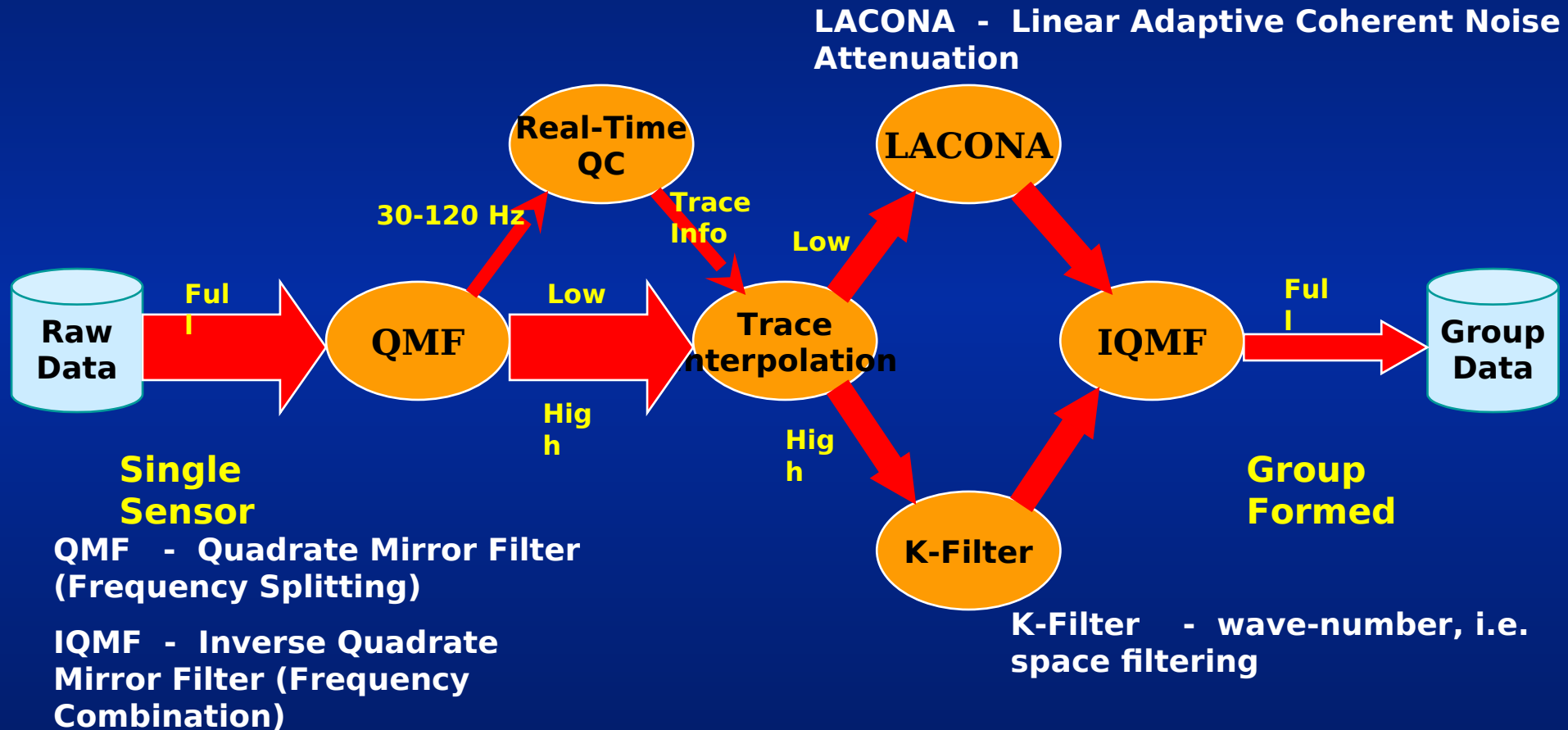
- **Q Processing Techniques**
 - **DGF / Lacona Filter**
 - **CMS**
 - **Receiver Motion Correction**
- **Generating Extra Revenue from Q**
- **Q Survey's (a Selection)**

Digital Group Forming (DGF)

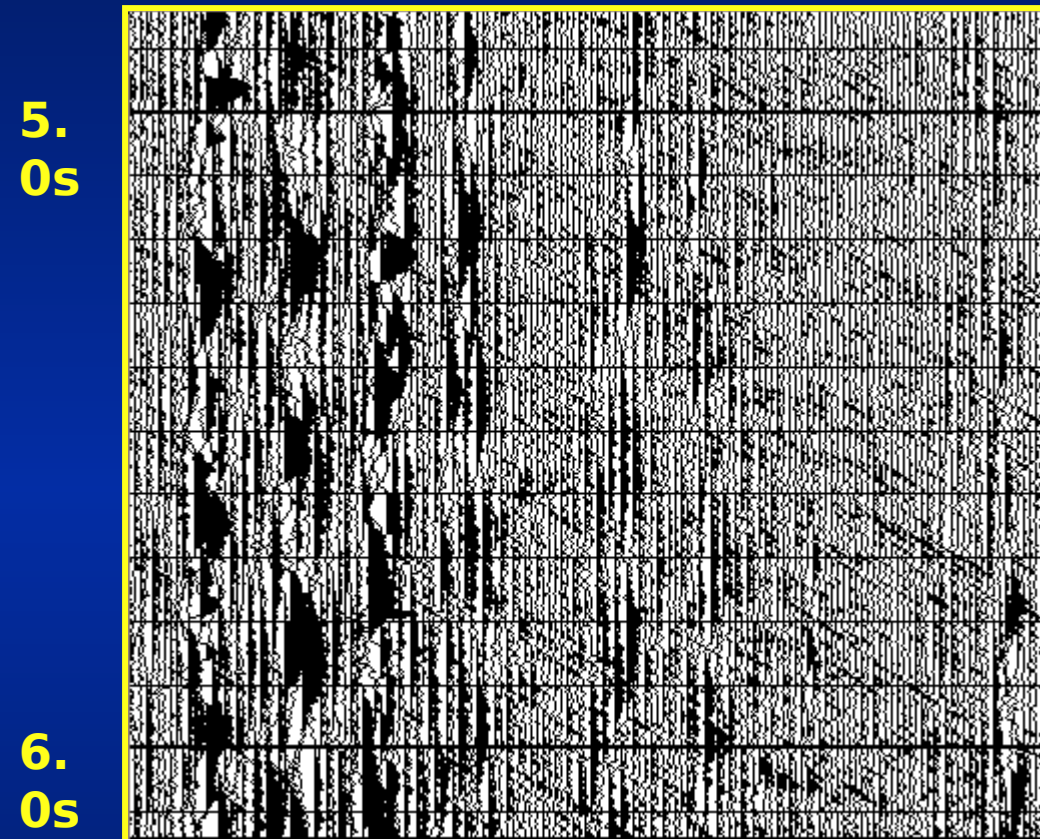


- DGF gives better signal preservation and enhanced frequency recovery of the signal particularly at far offsets, over traditional analogue techniques
- Data adaptive (LACONA) filtering of single sensor data during the group forming process can provide much better attenuation of swell noise.
- During on-board DGF, data is output at 12.5 m trace spacing, in the on-shore case DGF output is often 6.25 m to allow better spatial sampling.

OnBoard DGF

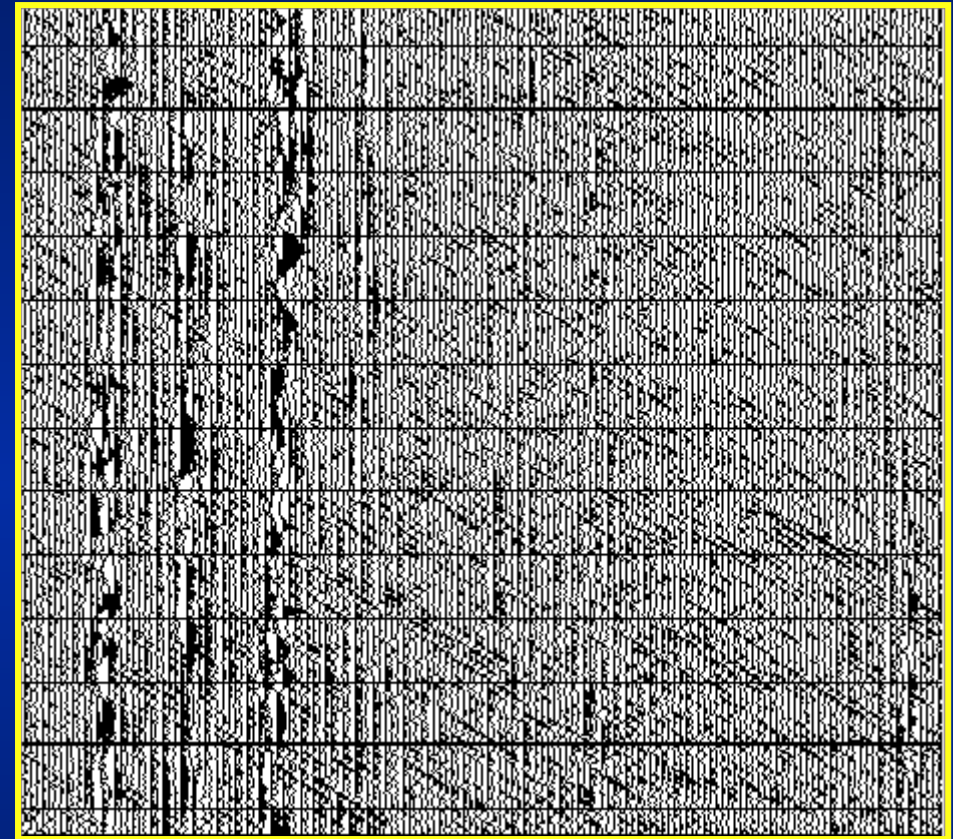


NE4 Vs. DGF - Shotpoint 1430, Sequence 97



NE4 Emulation Shot Shot

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2003
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Onboard DGF

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OnShore DGF

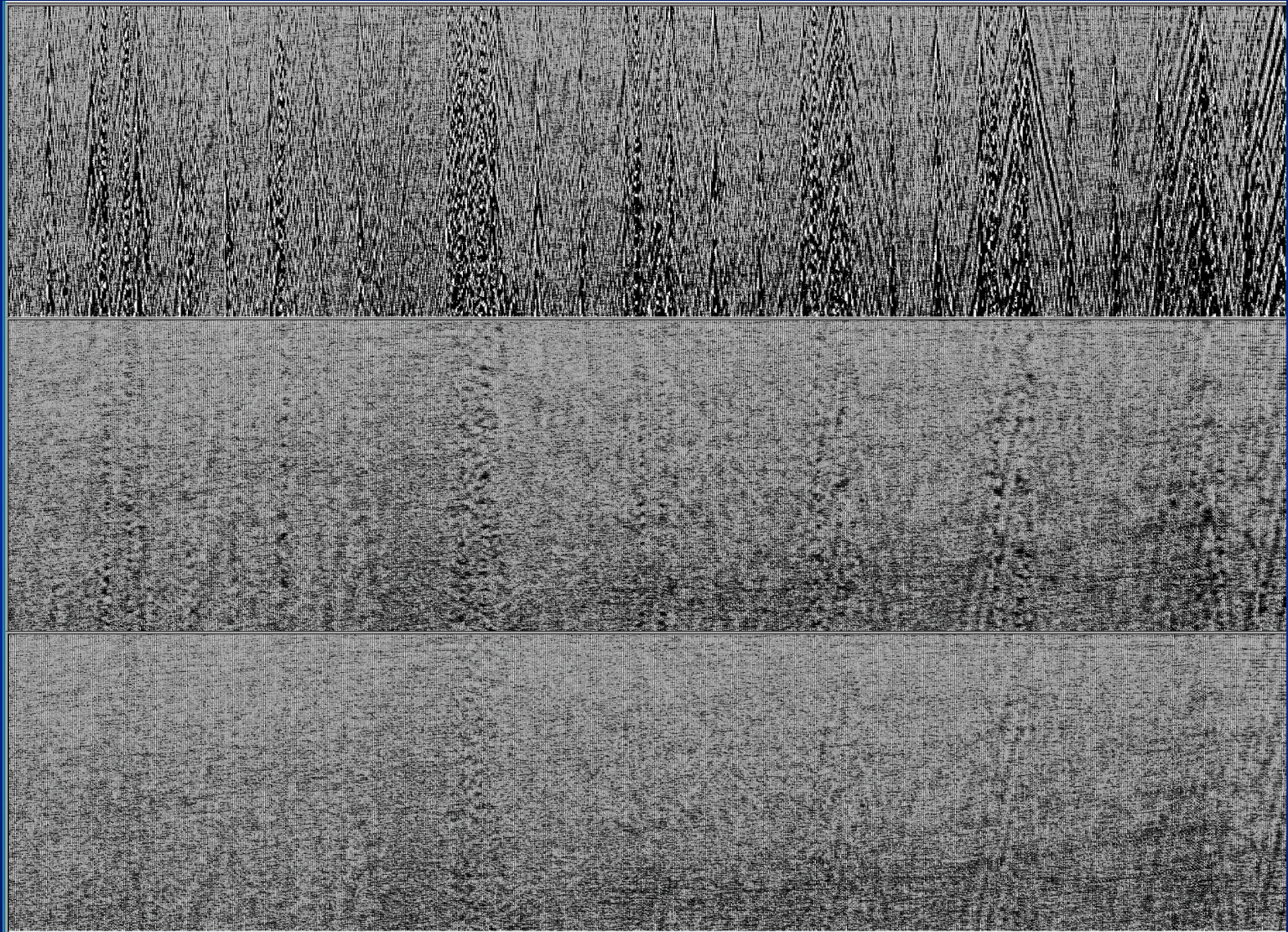
- Dead Trace Interpolation
- LACONA (Linear Adaptive Coherent Noise Attenuation) Filter
 - At 3.125 m trace spacing, swell noise is mostly coherent, appearing as low frequency, low velocity noise. While the seismic signal has higher velocities so we can attenuate the swell noise using a frequency/wavenumber filtering approach. Only frequencies between 0-31Hz are processed through the LACONA algorithm,
- SWATT (Swell Noise Attenuation)
 - SWATT transforms shot gathers into the frequency domain and applies a spatial median filter within time windows. Frequency bands that deviate from the median amplitude by a specified threshold are zeroed. Again only the low frequency data is passed through SWATT.
- Trace Drop

OnShore DGF

**Raw
SS**

**LACON
A**

**LACONA
+SWATT**



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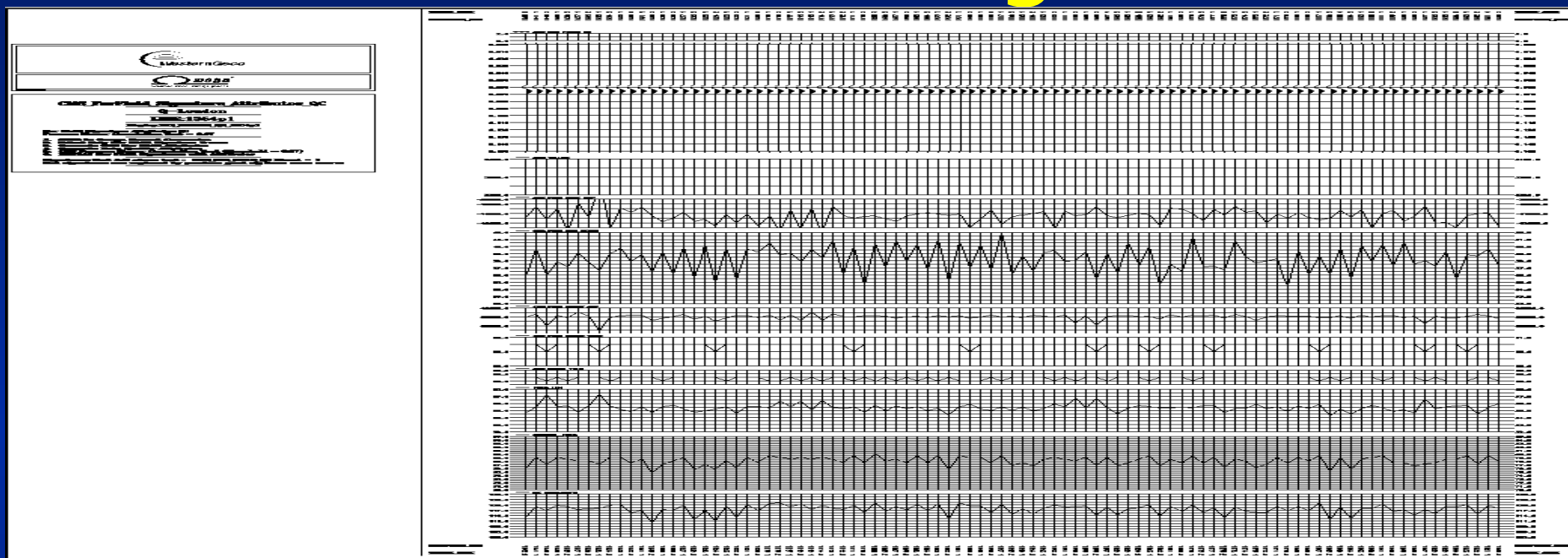
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CMS Processing

- CMS (Calibrated Marine Source)
 - CMS allows source-by-source designation to a chosen output wavelet. For each airgun in each array, a near field hydrophone measures the pressure field when the gun goes off. A notional signature is derived for each airgun, it can be thought of as the signature of an individual gun as if it had been fired in isolation, removing the interactions of neighboring guns. The notional signatures for each airgun in the array are combined to generate the far-field response for each shot. This farfield signature is recorded on an auxiliary trace in the SEG-D record for that shot.
 - The CMS Processing involves three stages
 - QC of Far field Signatures
 - Generation of Desired Output
 - Generation & Application of source-by-source designation operator

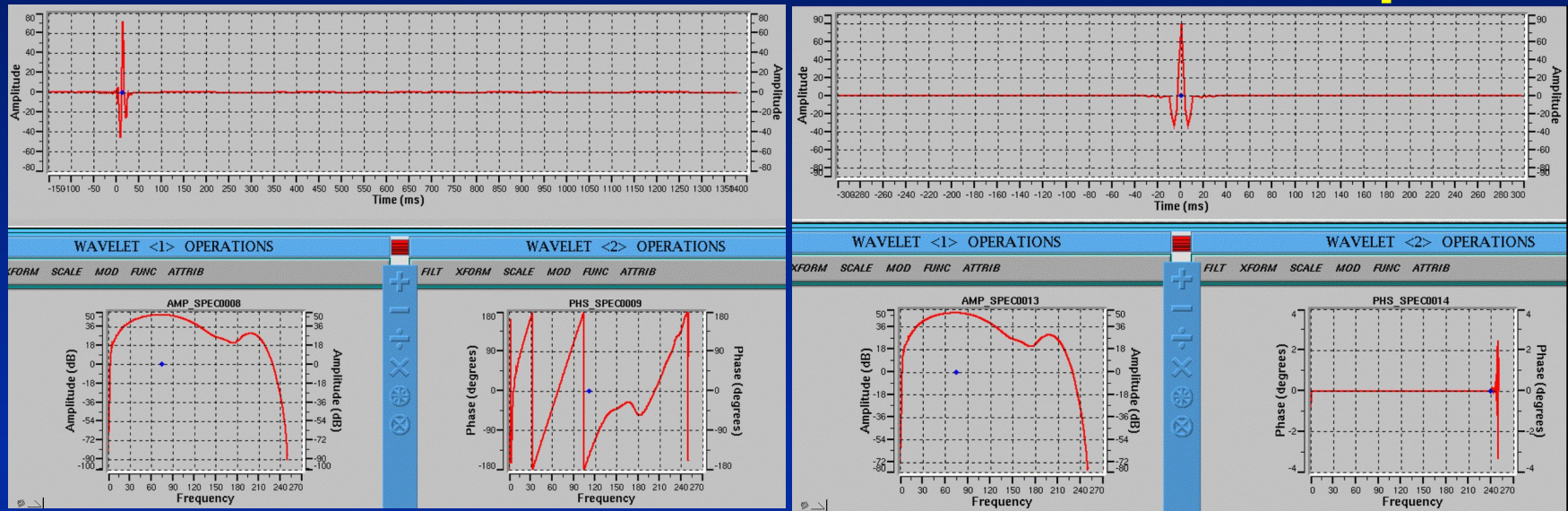
QC of Far Field Signatures



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- Several source attributes are extracted from each far-field signature: array volume, primary peak and ghost amplitudes and times, primary bubble ratio, central frequency.
- These are graphically displayed together with the far-field signatures to allow a visual QC for each sail line
- “Bad” Signatures can be replaced by a neighbour or an average signature

Generation of Desired Output

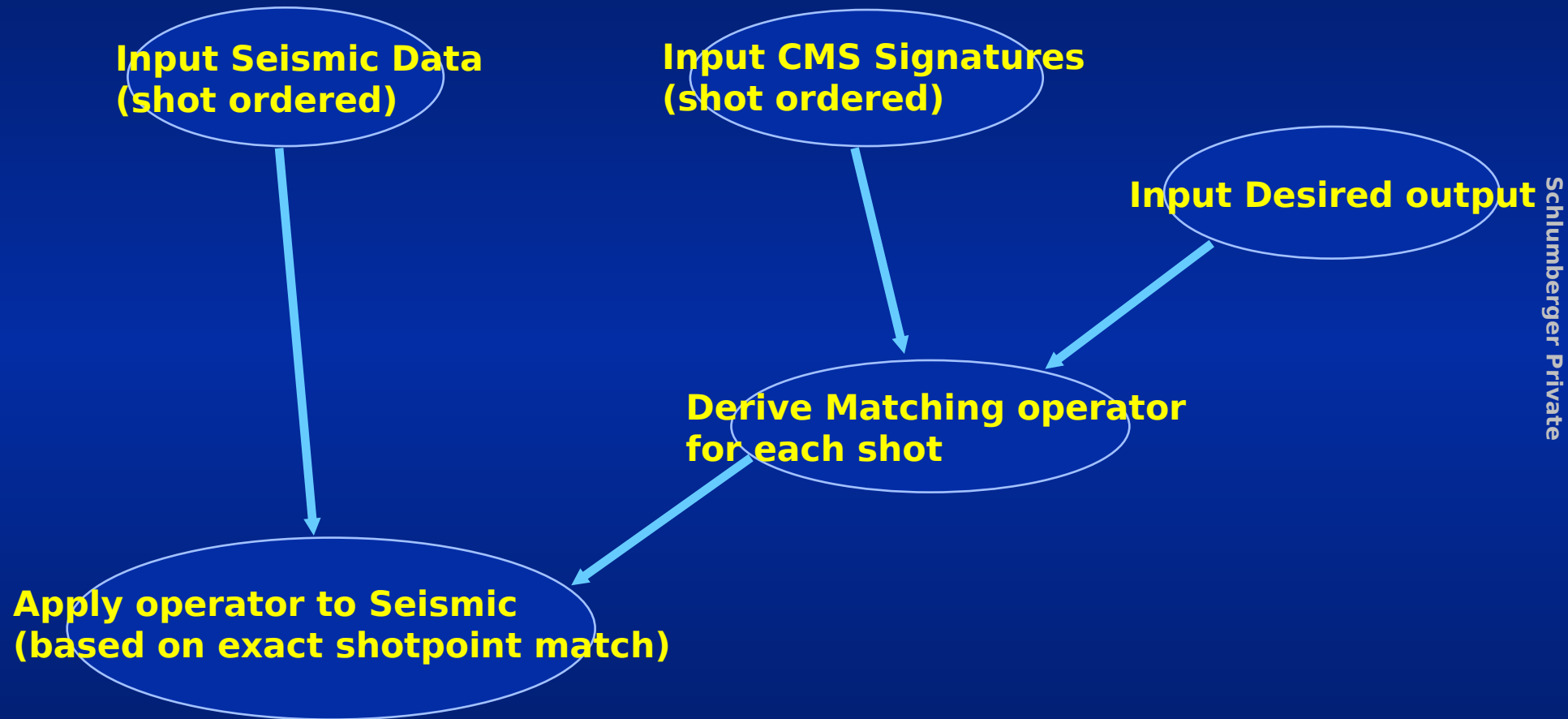


Far Field signature after removal of ghosts and debubble

Desired Zero-phase output

- Using the Omega Application SWP (Seismic Wavelet Processor)
- SWP can be used to remove cables ghosts and bubble effects, it can also be used to create a minimum or zero phase output as desired
- Finally it generates the actual designature operator which is applied to each shot to give the desired output

Derivation and Application of Operator



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Receiver Motion Correction

• In marine acquisition, the continual in-line motion of the receivers after the source has fired causes positioning errors that are time-variant. The correction is a 2D process, applied one cable at a time and assumes that feathering does not exist. The data is shifted to the correct position in a time-variant fashion. The amount of shift in units of channel numbers is computed by the following equation:

$$\text{Shift}(J) = \frac{\text{SAMP_INT} \times \text{BOAT_SPEED} \times (J - 1)}{1000.0 \times \text{RECVR_STN_SPACING}}$$

• It applies a spatial correction to the data that has the following characteristics:

- The correction shifts data towards the front of the cable.
- The amount of correction increases with record time.
- The amount of correction increases with the speed at which the cable is towed.

Receiver Motion Correction

• INPUT DATA PREREQUISITIES

- RMC requires that the input data be shot gathered (either a sail line swath or single sub-surface line).
- Missing traces are permitted within a cable, however it is advantageous to fill missing traces with interpolated data before applying RMC.
- It should be performed as early in the processing sequence as possible.
- The data input to RMC should not have NMO correction applied.

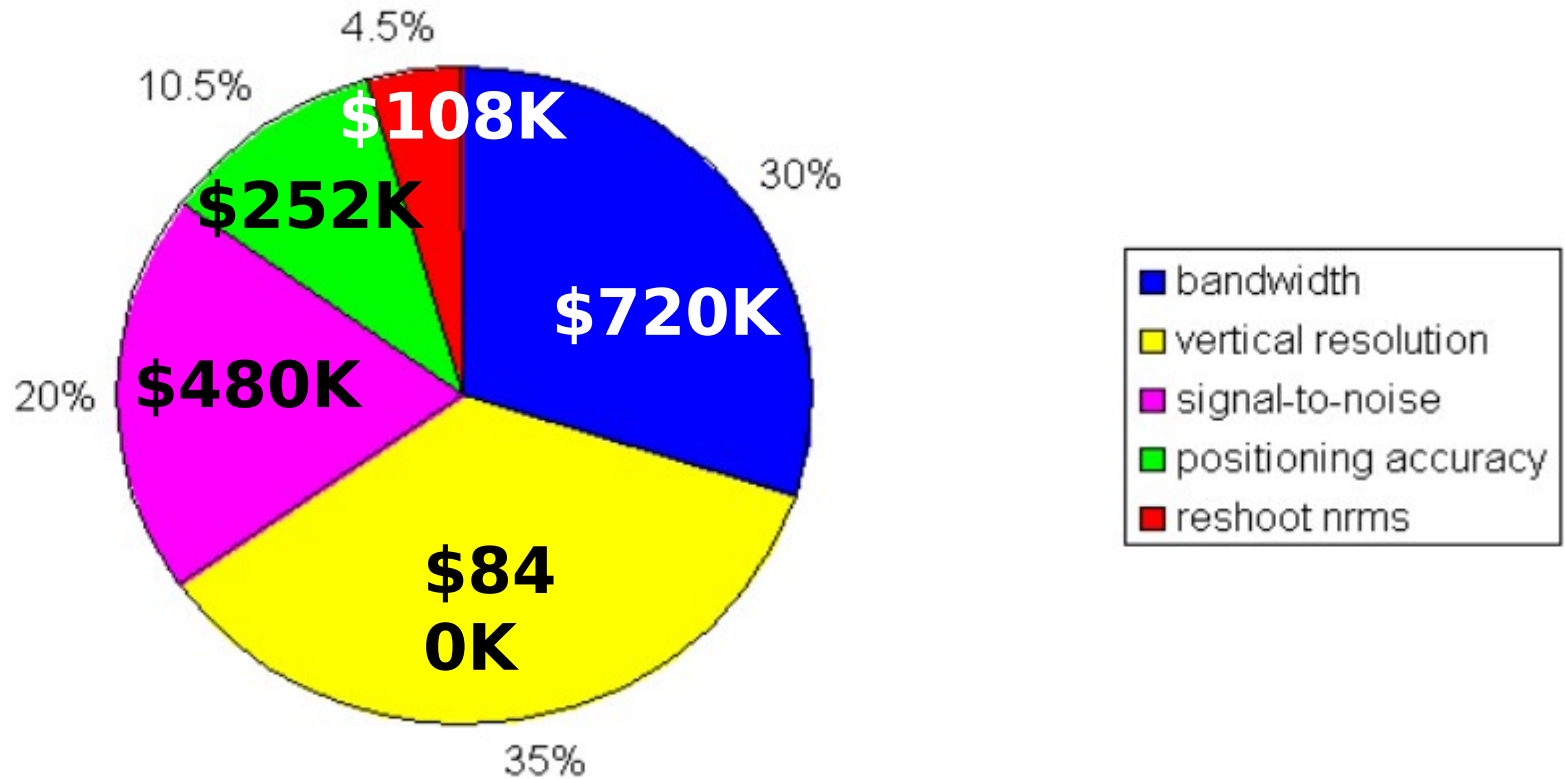
• QC of RMC

- QC of the effectiveness of RMC is difficult. The effect on the data is very subtle. The improvement in data quality is theoretical rather than measurable. Representative shot displays before and after the process do little more than check if obvious errors have been introduced.

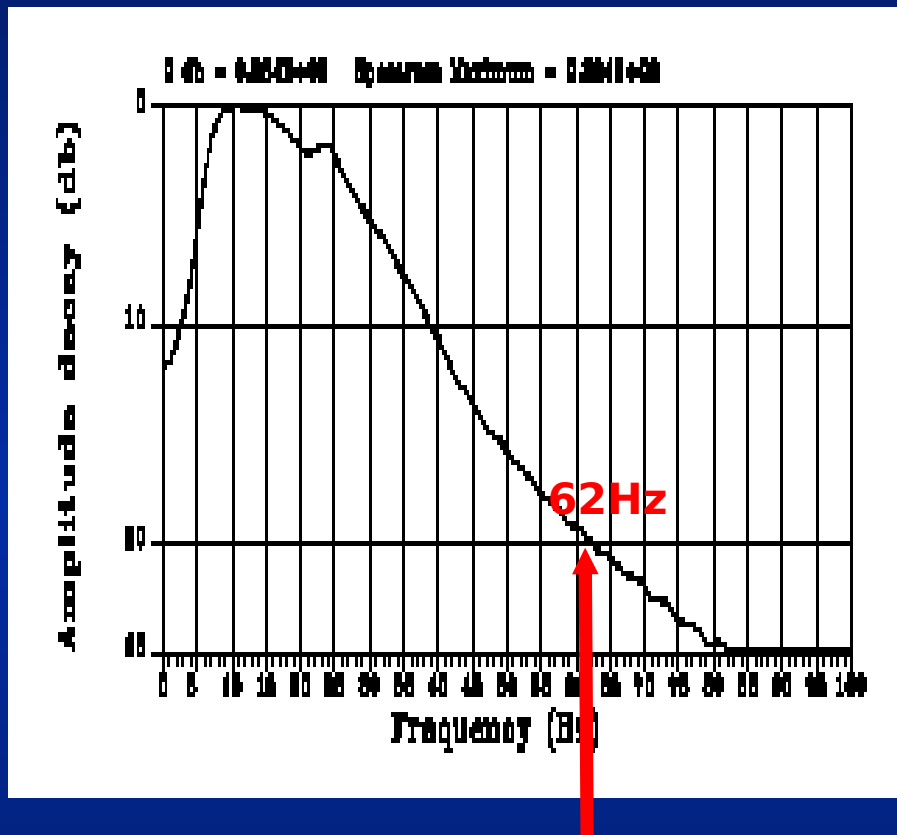
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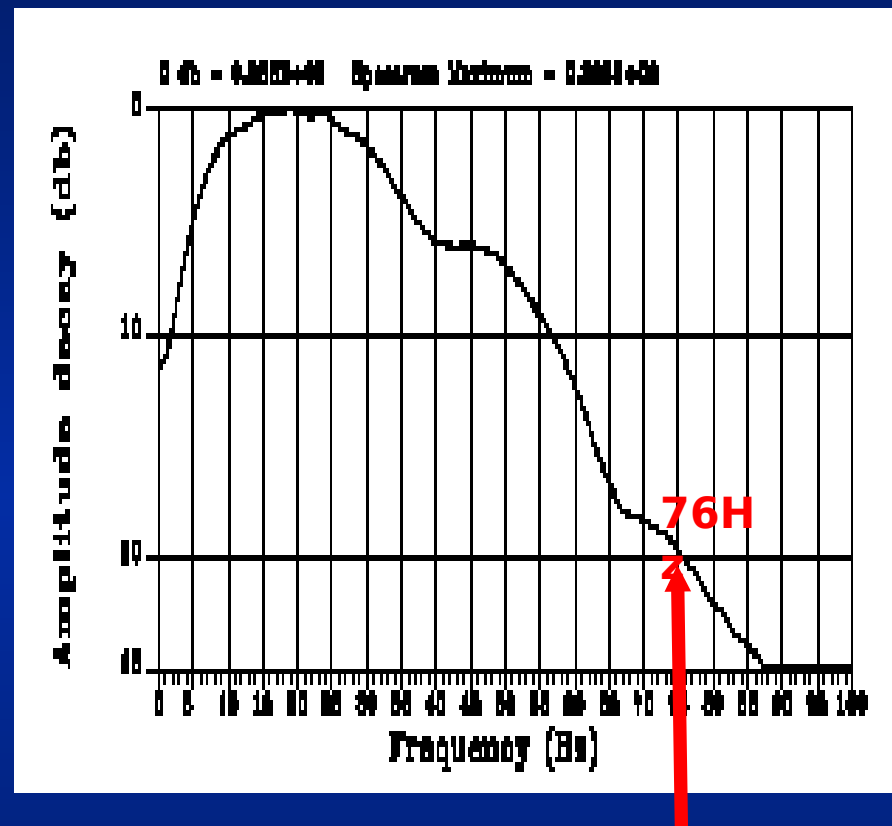
BP Magnus Q metrics



Minicube1 Bandwidth Results

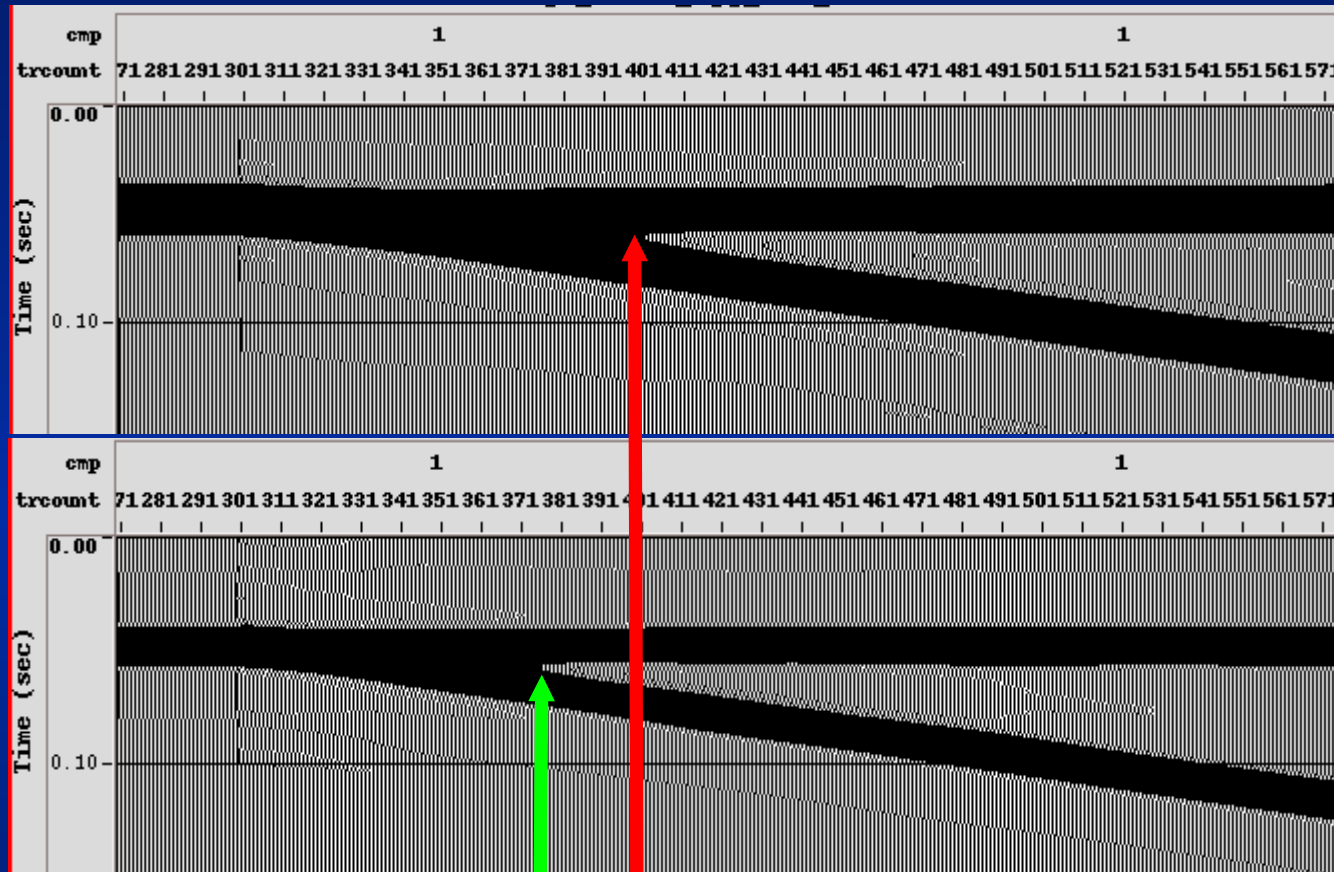


CGG Volume



Final Q Volume

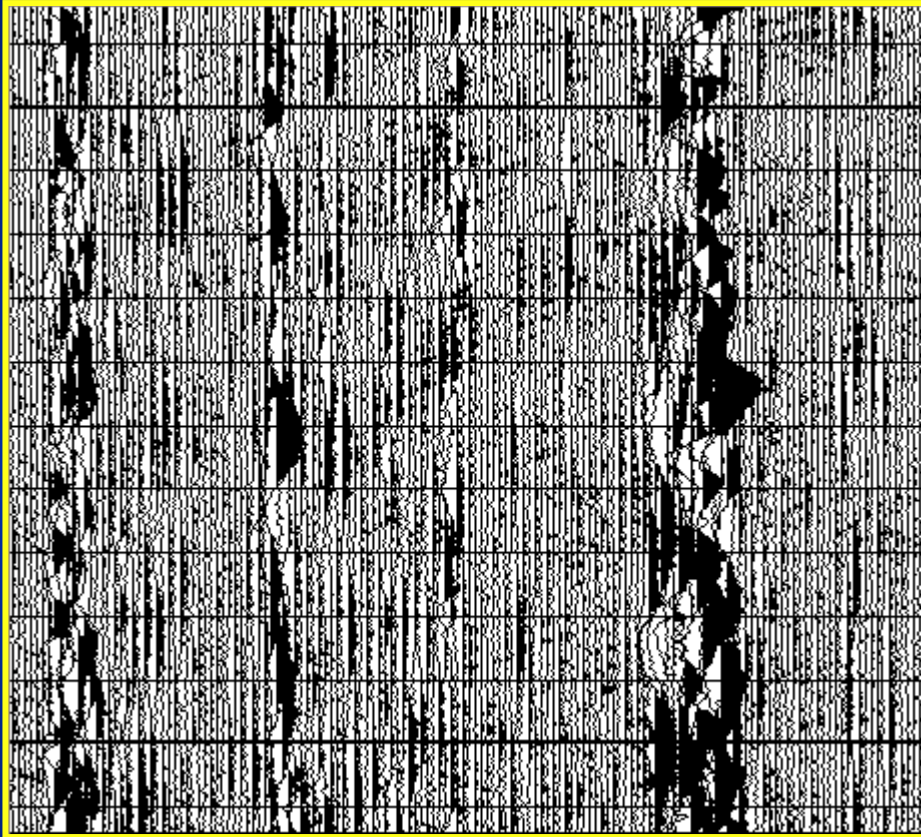
Minicube1 Wedge Model Results



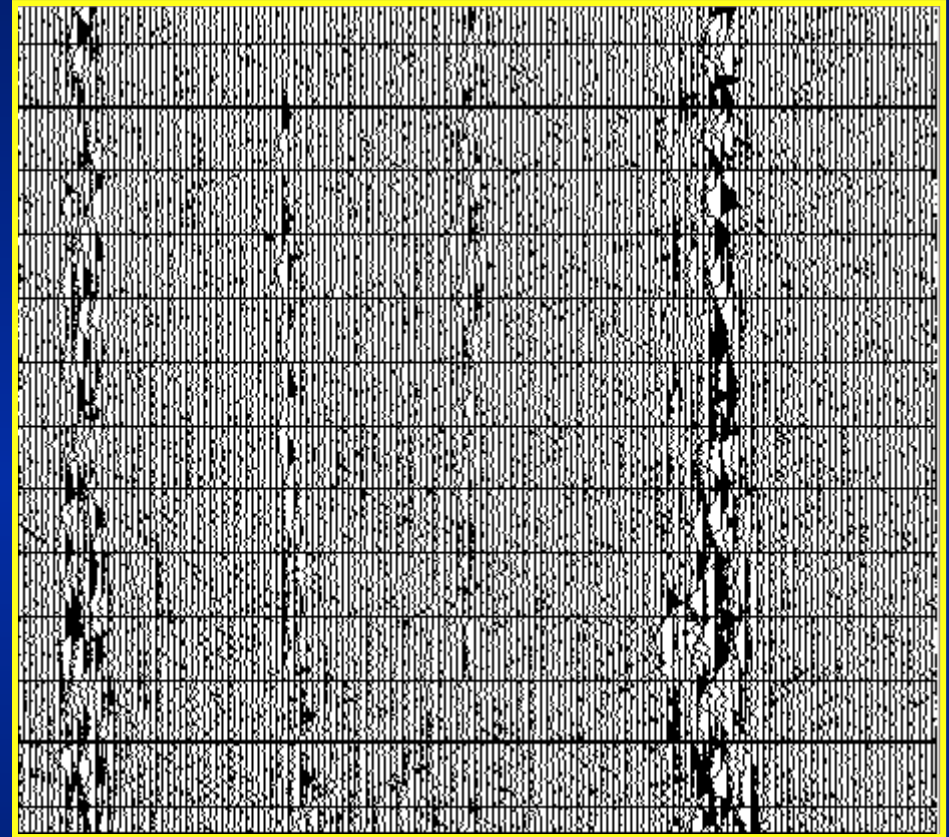
CGG VOLUME
FINAL Q VOLUME

NE4 Vs. DGF - Shotpoint 1565, Sequence 96

5.
0s



6.
0s



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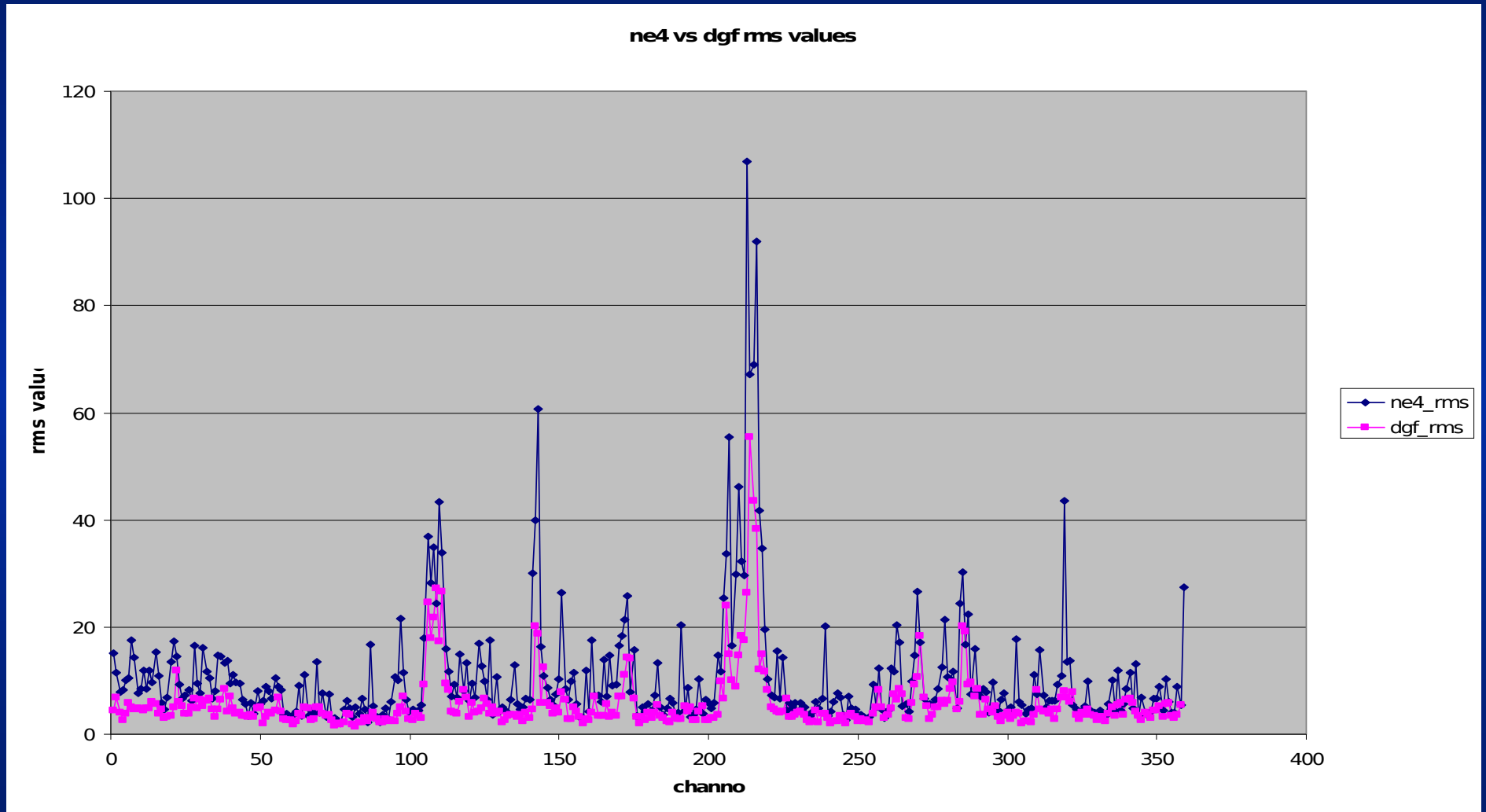
NE4 Emulation Shot

Onboard DGF

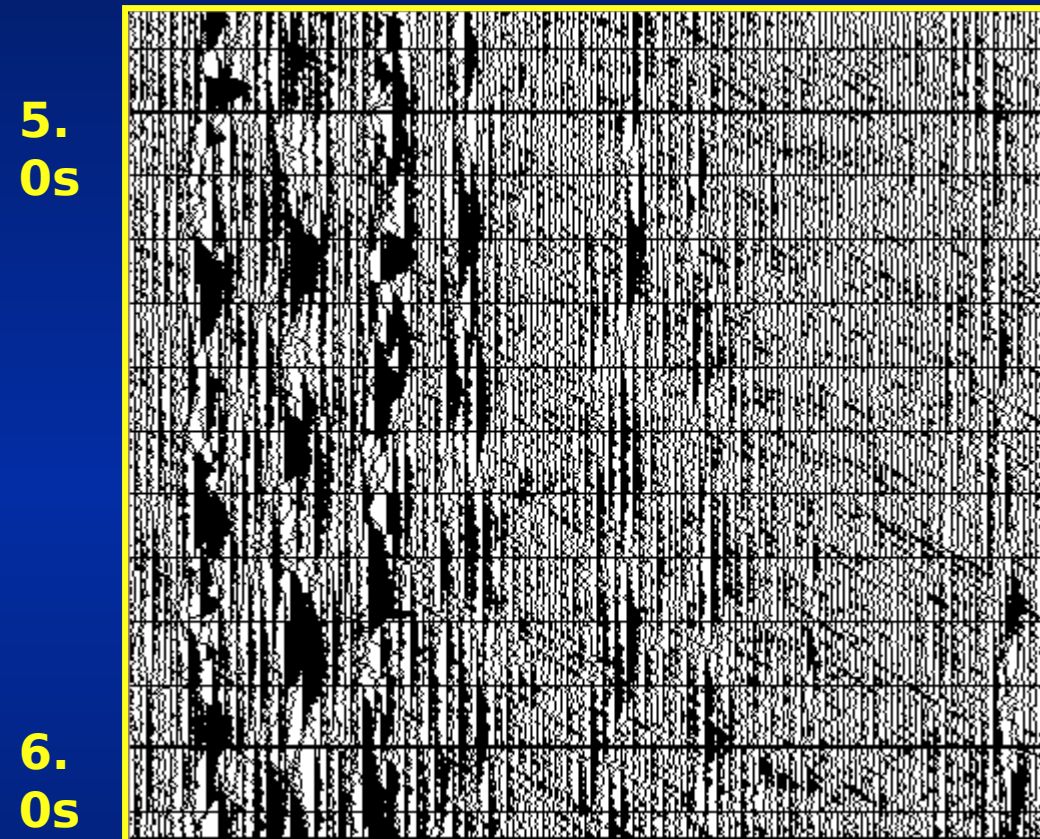
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2003
X-training Seismic Managers



Rms values for Shotpoint 1565 on sequence 96

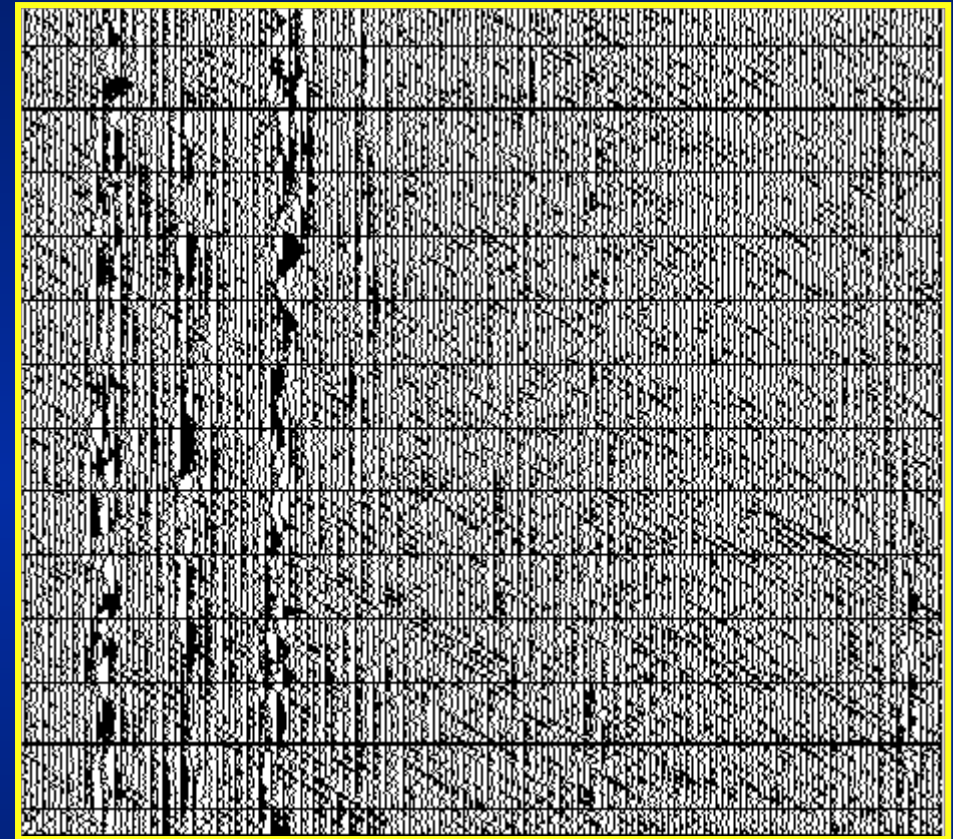


NE4 Vs. DGF - Shotpoint 1430, Sequence 97



NE4 Emulation Shot Shot

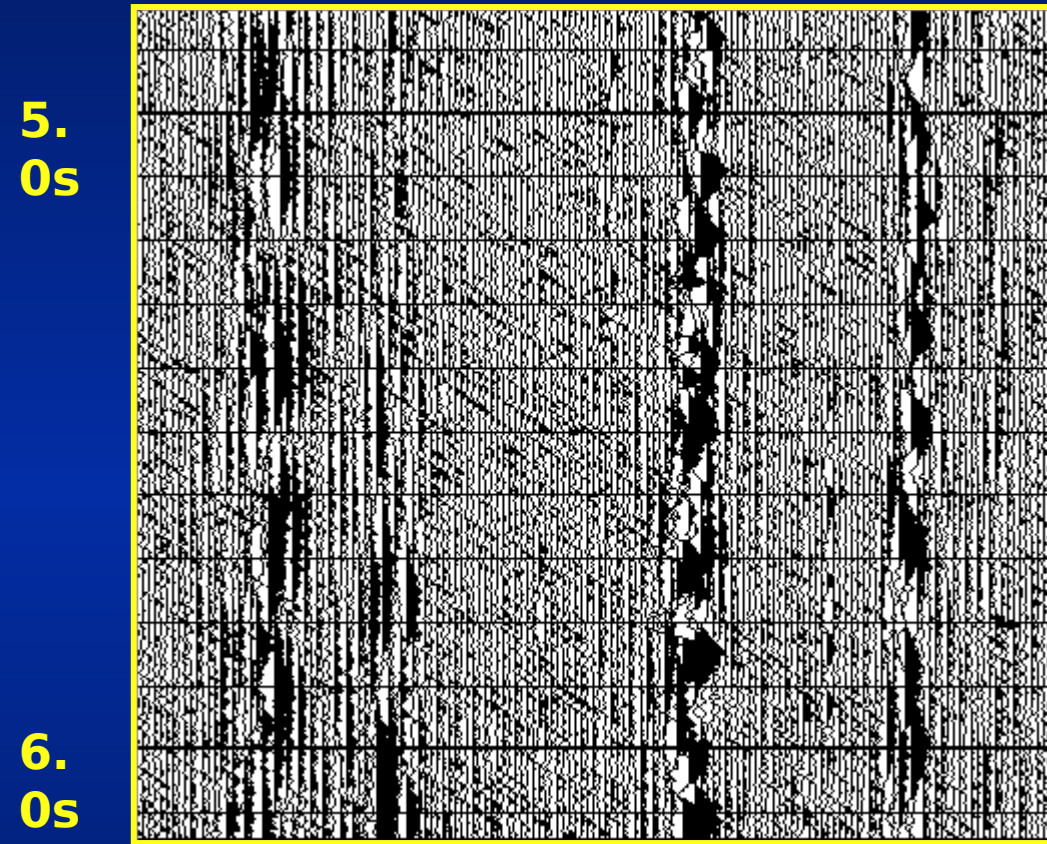
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Onboard DGF

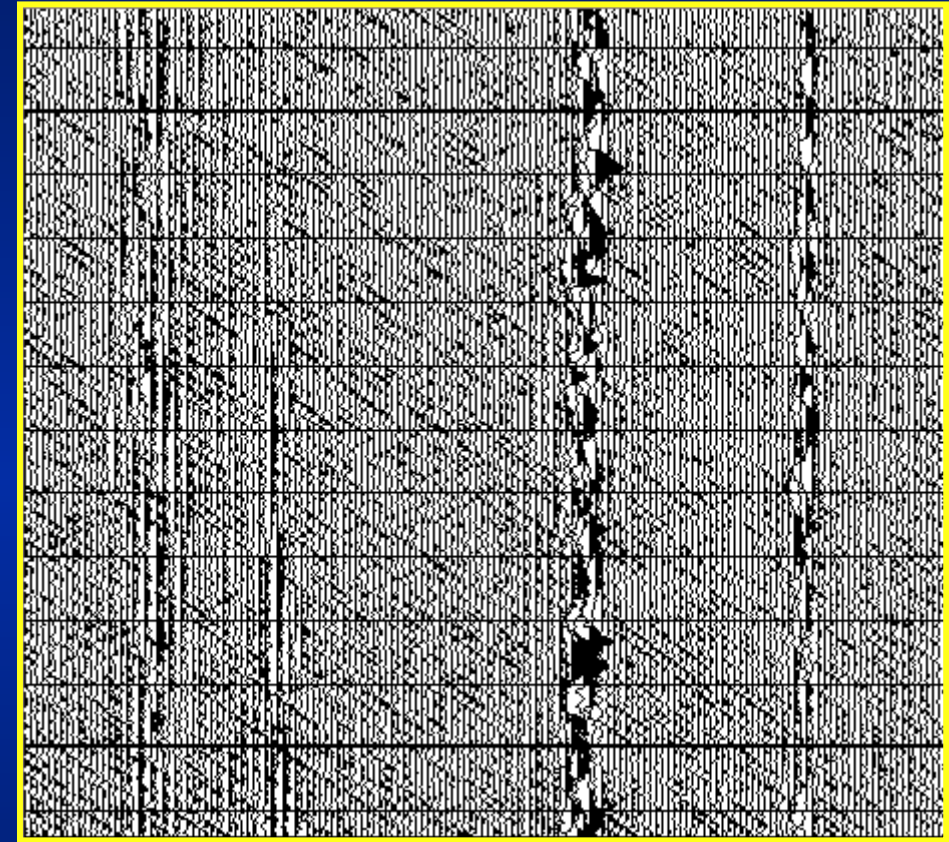
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NE4 Vs. DGF - Shotpoint 1450, Sequence 134



NE4 Emulation Shot Shot

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Onboard DGF

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Magnus Metrics

- **Metric targets**

- **Bandwidth: 0 - 40%**
- **Resolution: 0 - 25%**
- **Swell / cable S:N: 0 - 4db**
- **Repeatability: 12 - 3m SMA**
- **Repeatability: 40 - 25% NRMS**
- **Total = 0 - 100% of metrics**

- **Metric Achievement**

- **20% improvement**
- **50% improvement**
- **4.09db**
- **5-6m**
- **25%**
- **Total = 83% of bonus**

\$1.99M Extra in Bonuses

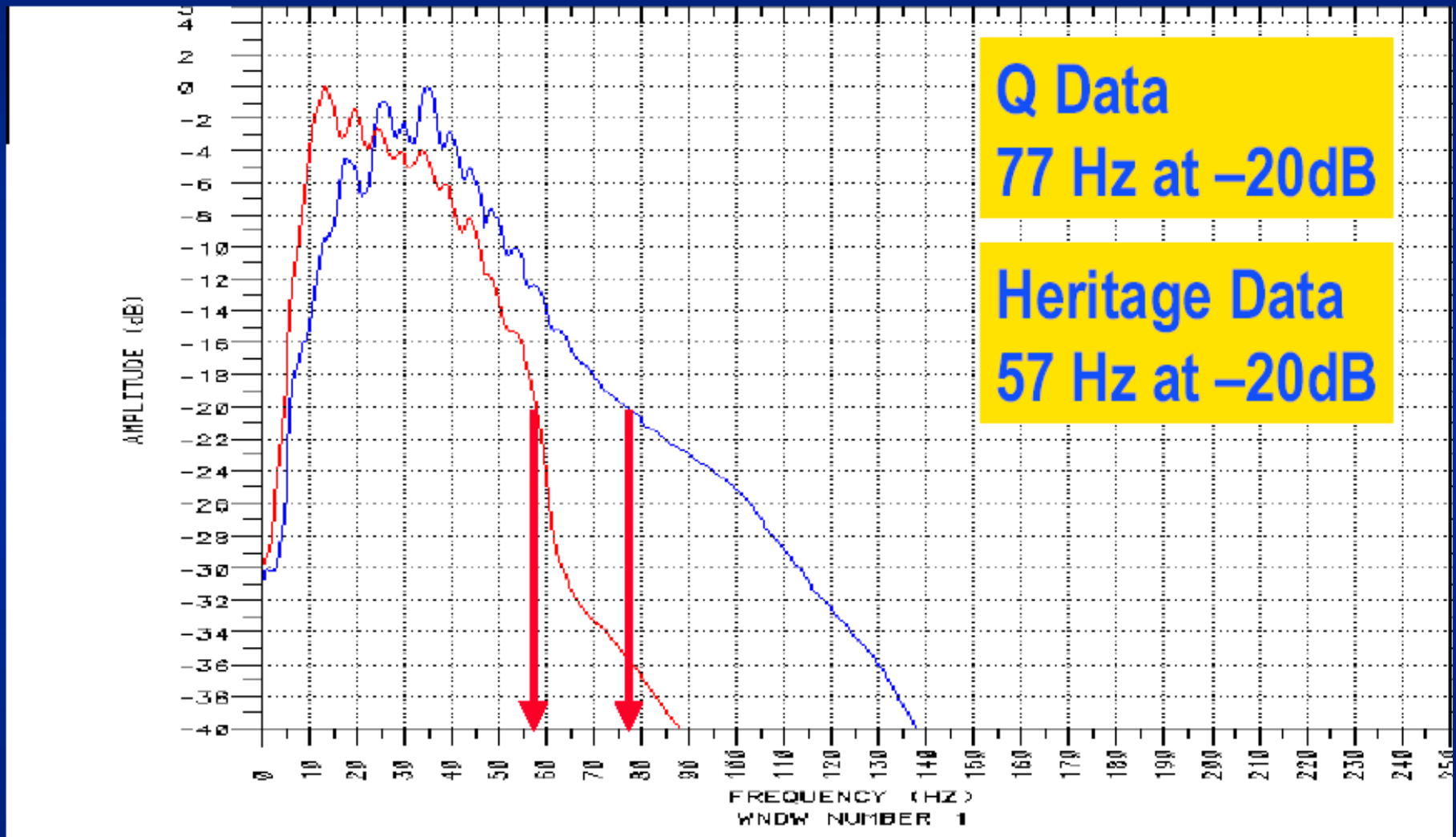
of which data processing got \$100K

Murchison Metrics

- **Metric targets**
 - **Resolution: 0 - 40%**
 - **S/N low**
Frequencies: 0 - 4db
 - **S/N High**
Frequencies: 0-12db
 - **Total = 0 - 100% of metrics**
- **Metric Achievement**
 - **35% improvement**
 - **4.81db**
 - **5.5db**
 - **Total = 80% of bonus**

\$1.5m Extra in Bonuses

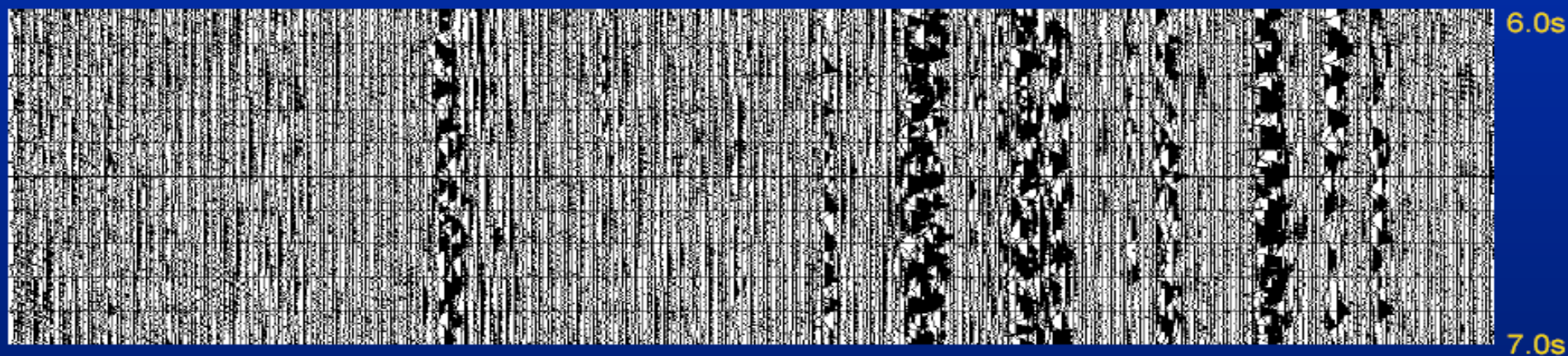
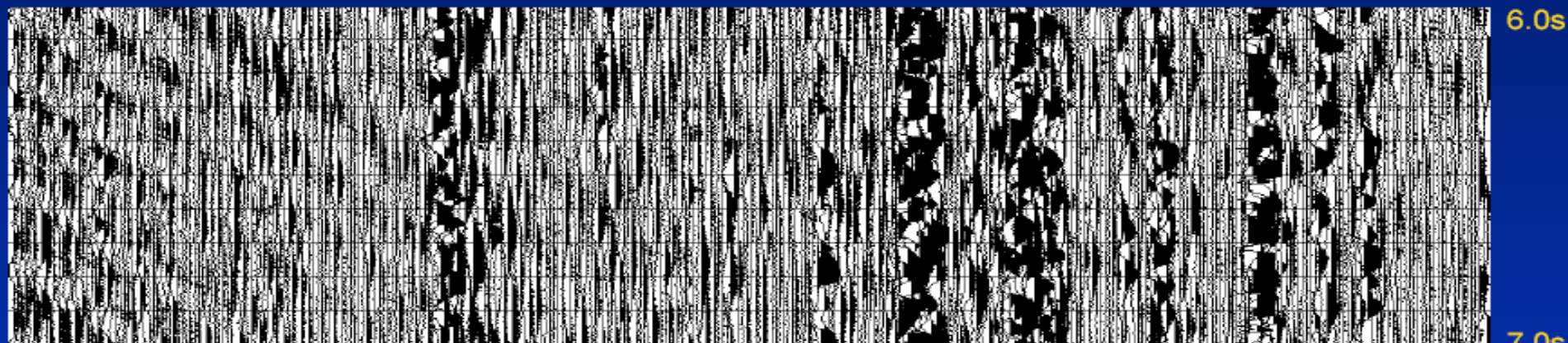
Murchison Bandwidth Metric



Murchison Metric

Metric 2A: N4E vs DGF: Sequence 085, Shot 1580

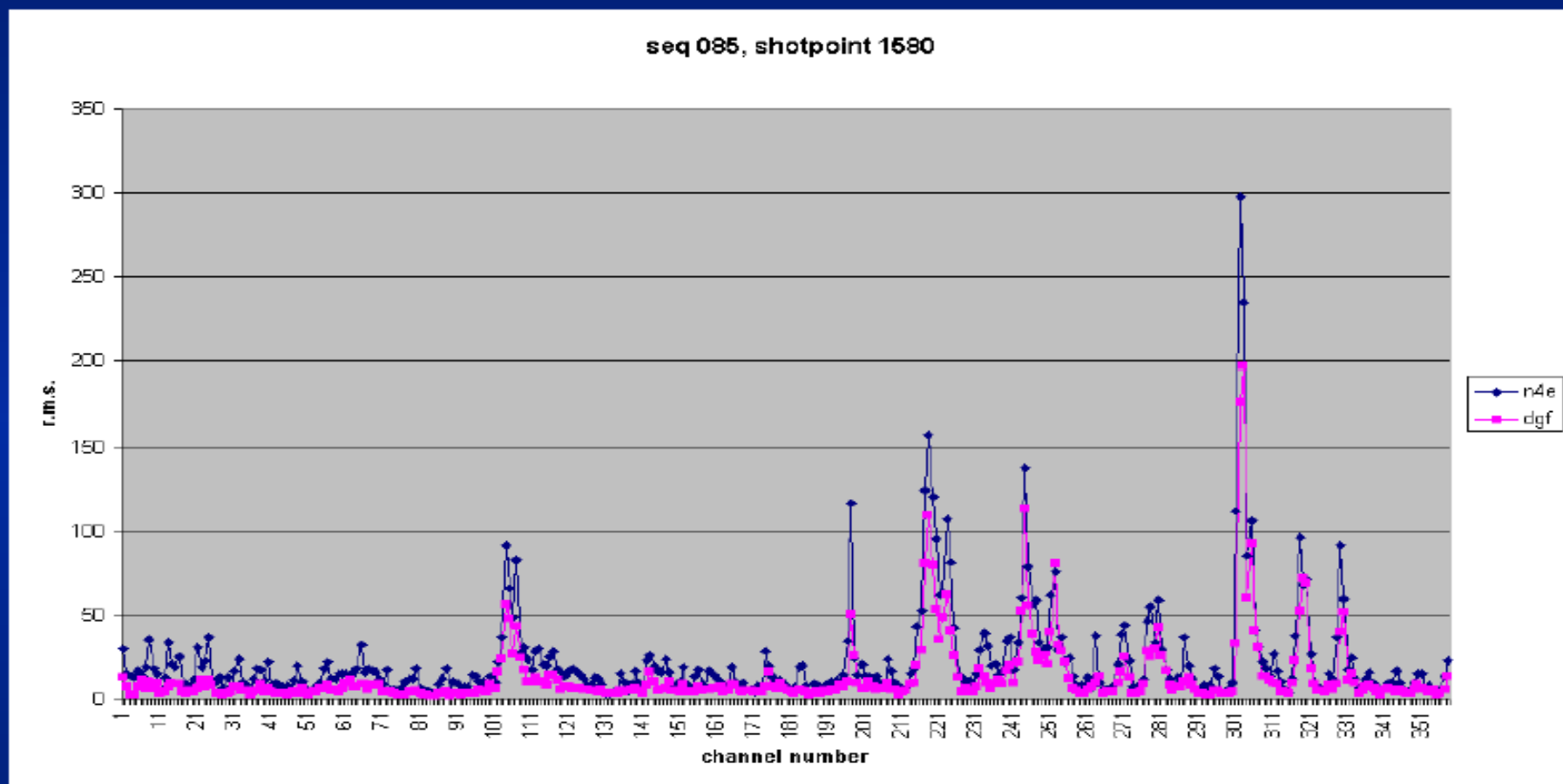
N4 Emulation Shot



Onboard DGF Shot

Murchison Metric

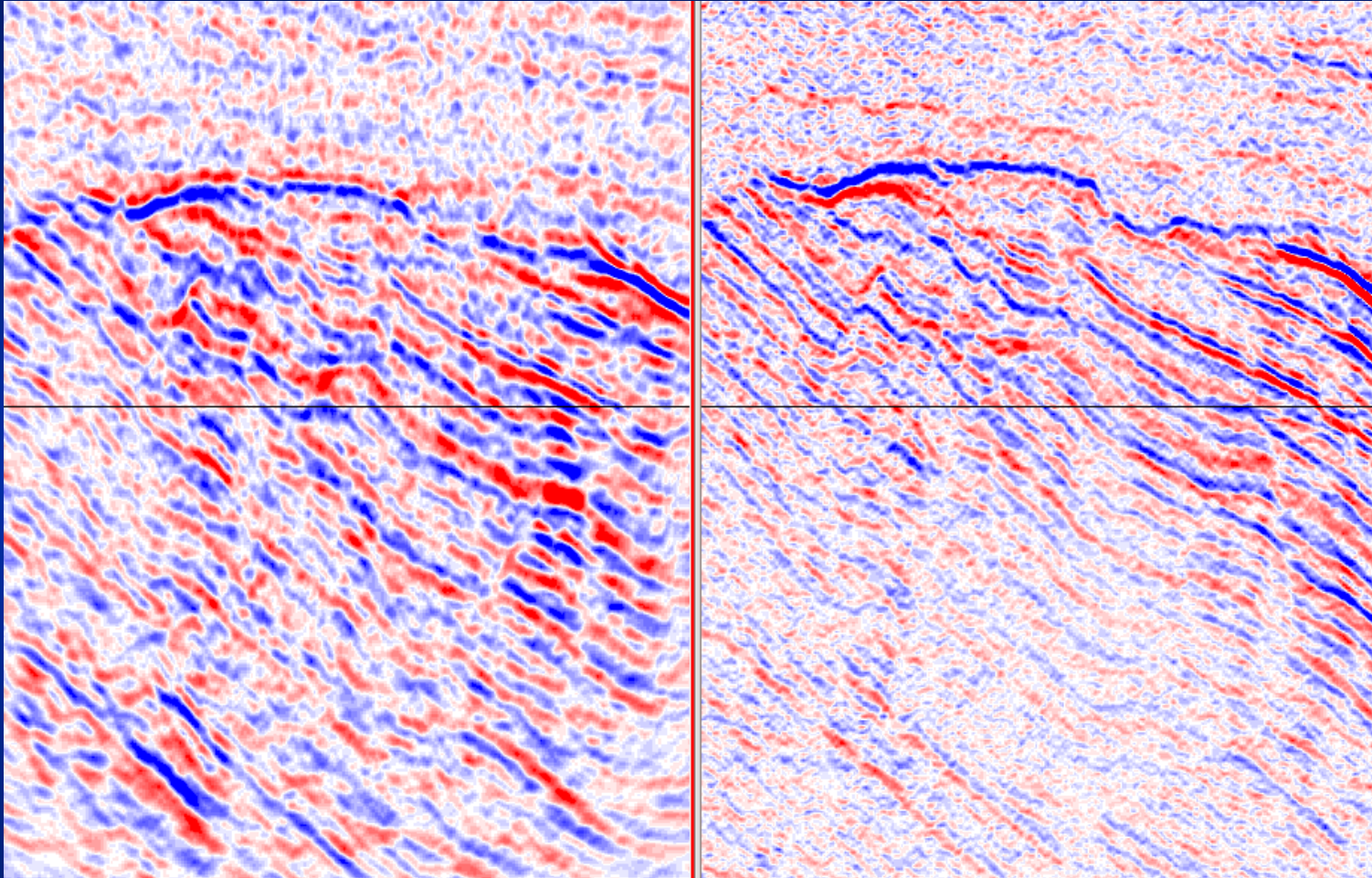
Metric 2A: r.m.s. values: Sequence 085, Shot 1580



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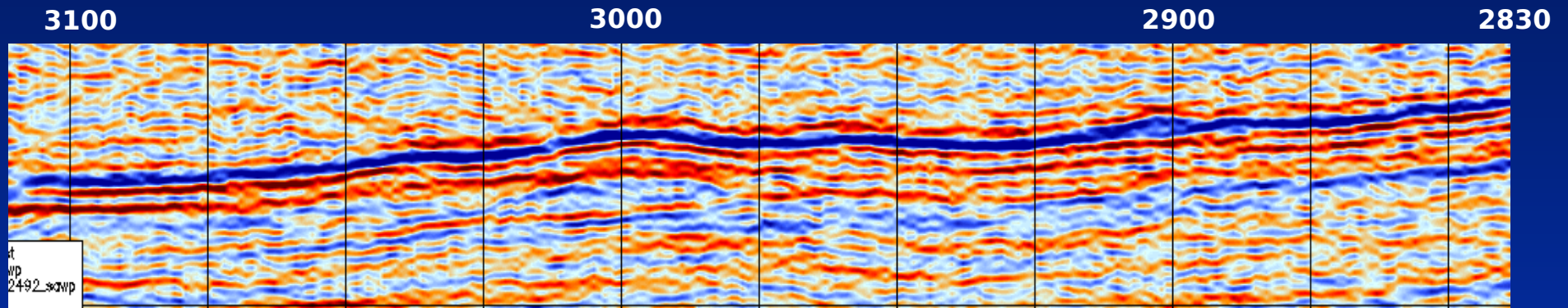
Magnus



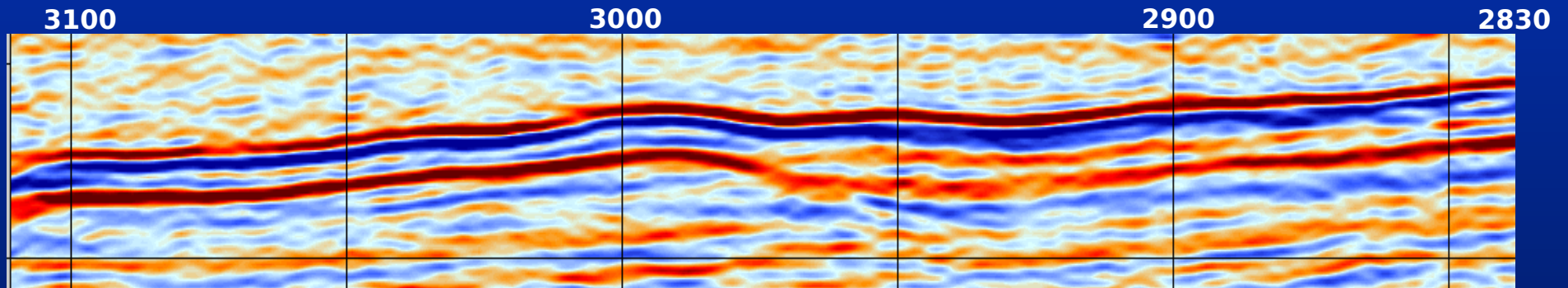
Heritage ('99) Magnus

Q Magnus

Murchison



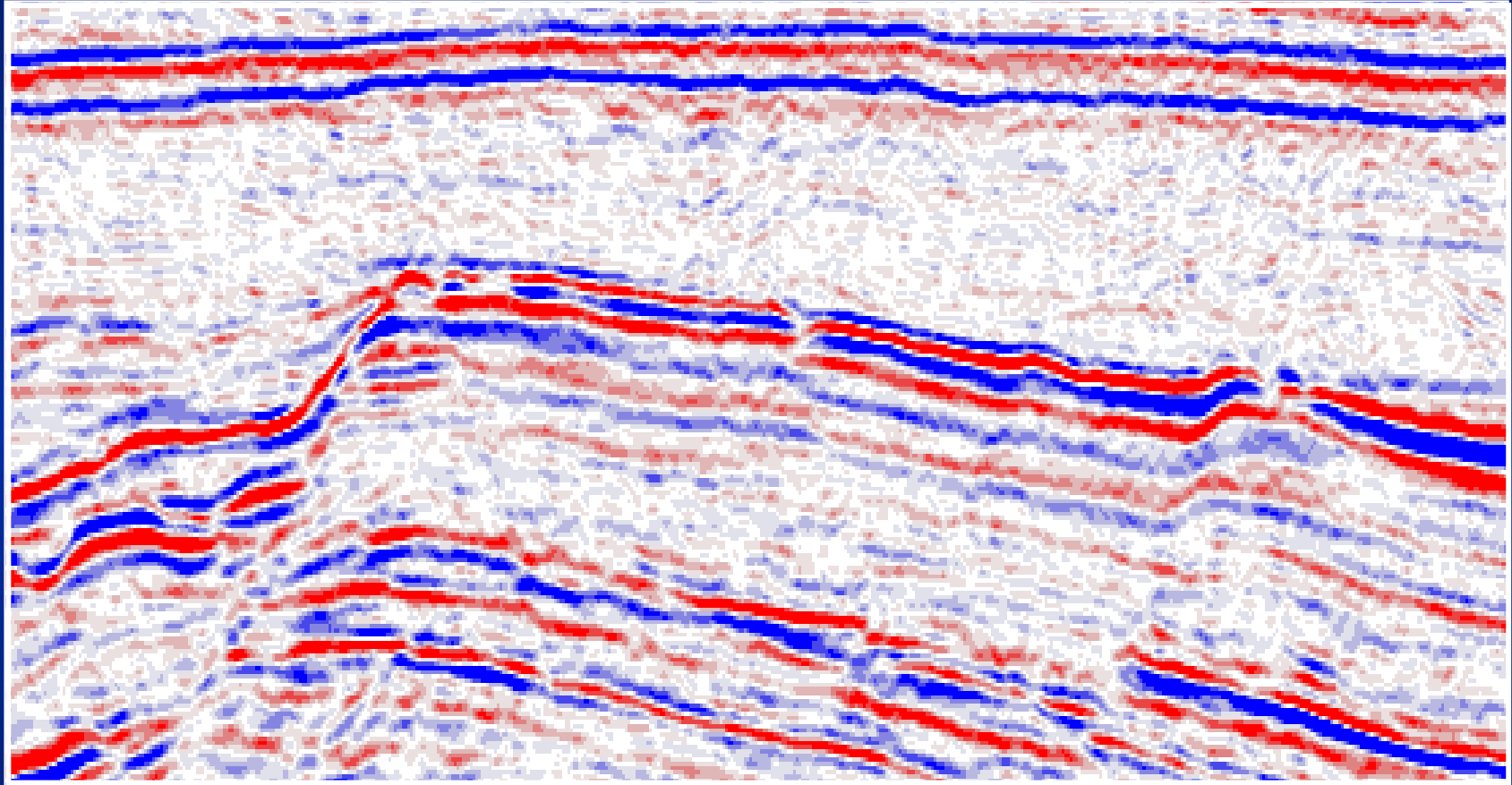
Q - Reservoir data



Heritage data

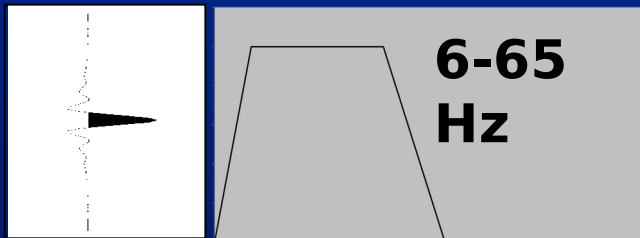
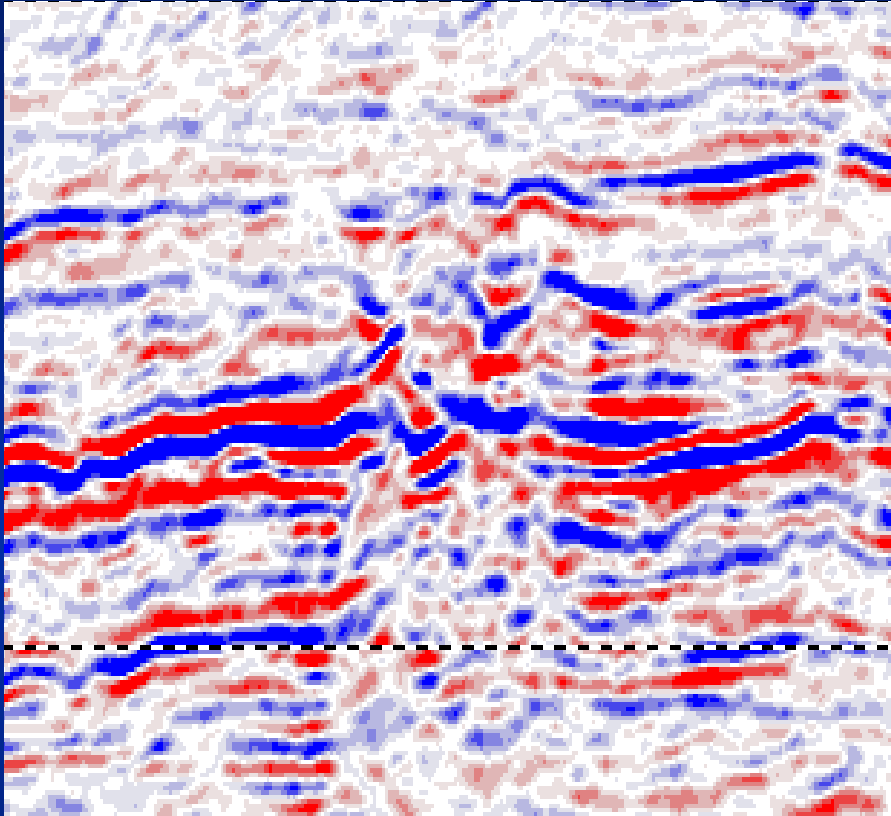
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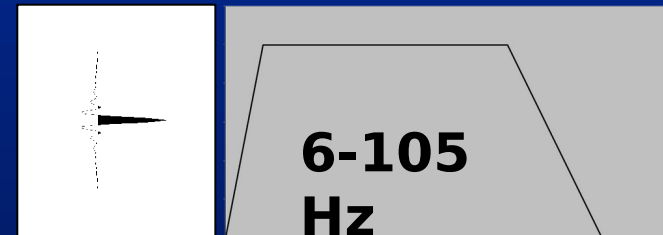
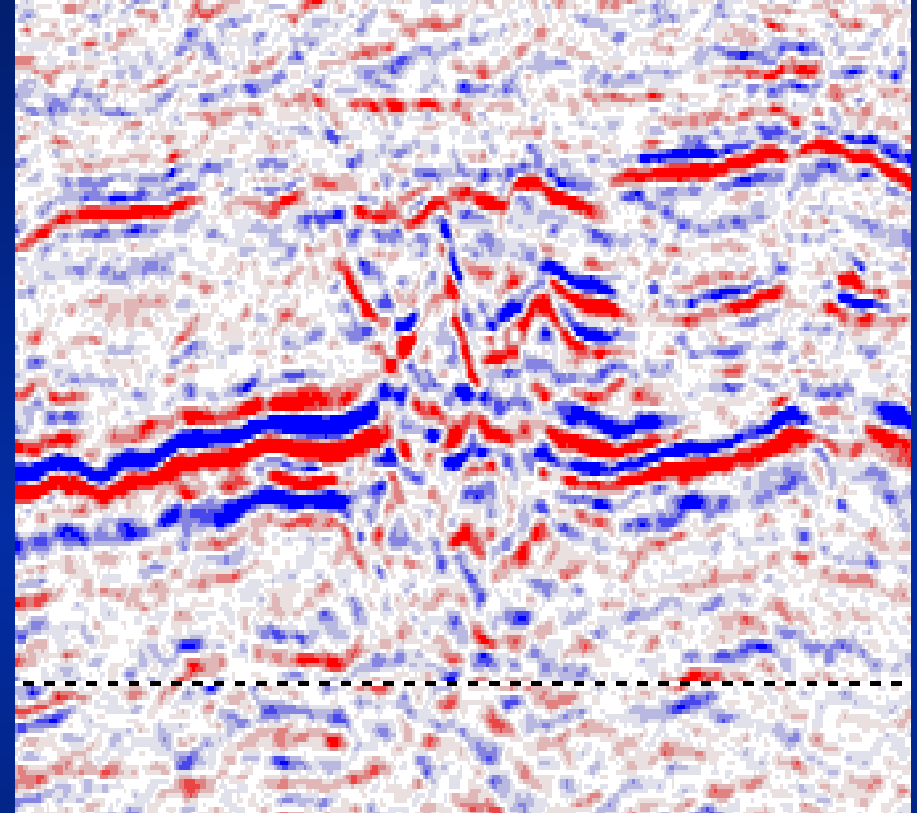
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Leadon



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**Heritage
survey**

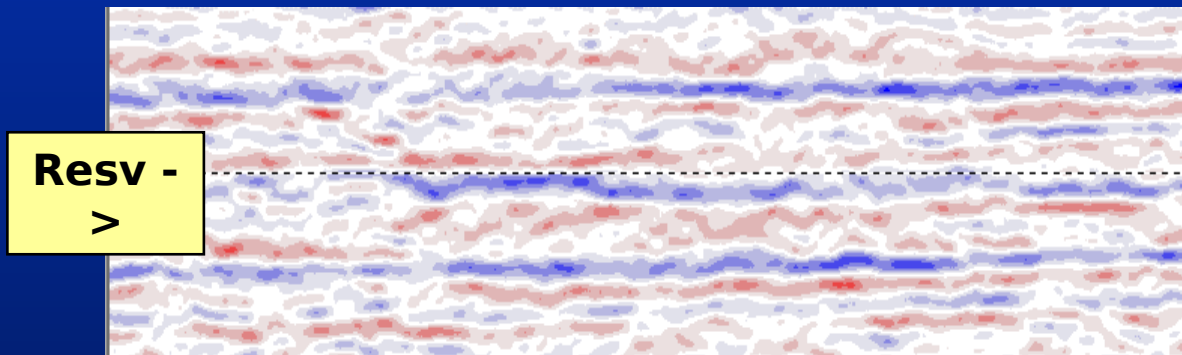
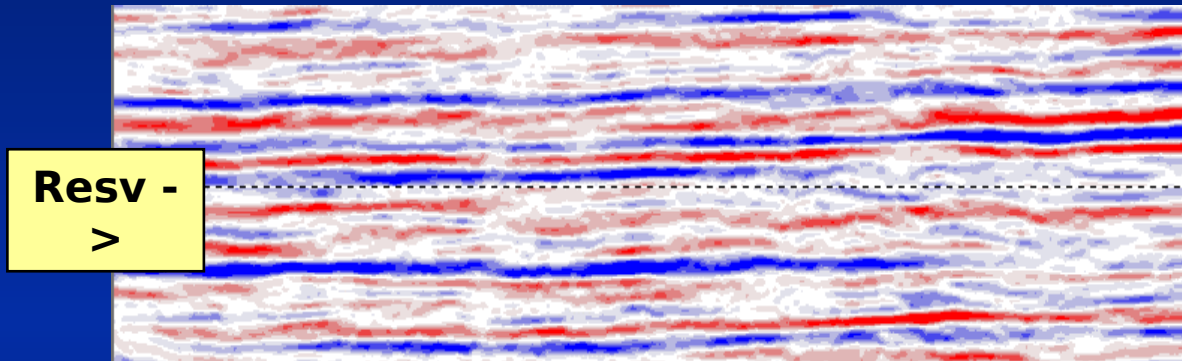


Q survey

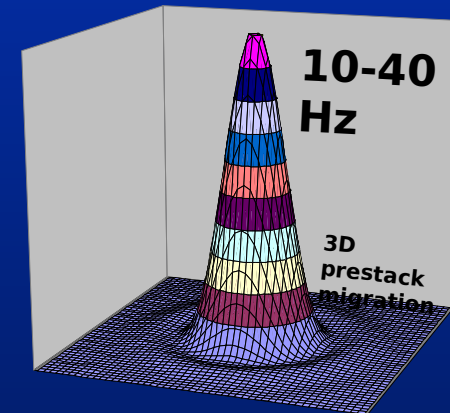
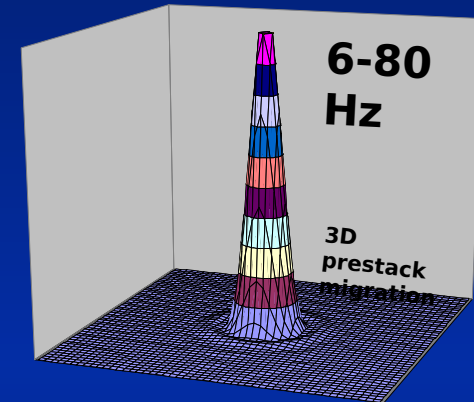


Hassi Messaoud

Q-Land 3D data



Legacy 2D
data



How Far have we come?

“In Practical terms all I could see with the old data was a tall skyscraper. Now we can start to see some of the individual floors.”

Glen Morton, Kerr McGee